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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

BOP2024 – PRINCIPLES OF OPERATION RESEARCH (All Section/Group)

03 March 2016
2.30pm – 4.30pm
(2 Hours)

INSTRUCTION TO STUDENT

1. This question paper consists of **FIVE (5)** pages including cover page with **FOUR (4)** Questions only.
2. Attempt **ALL** the questions.
3. Please write all your answers in the Answer Booklet and Graph Papers provided.
4. The distribution of the marks for each question is given. Total marks 100.

QUESTION 1 (25 marks)

- a) Nippon Light Metal has three types of LED downlight (Ultrathin, ESE27 and UFO Series) and five markets (J, K, L, M, N) where downlight is demanded. The annual quantities of downlight available in three sources of supply are 45, 35 and 50 million units for Ultrathin, ESE27 and UFO Series respectively. The amount that can be sold at the five markets is 32, 42, 22, 30 and 24 million units for J, K, L, M, N respectively. The company transports all the downlight by lorries. The unit cost of shipment is \$1,000 along the various routes is described in the table below.

Table A: Cost per Unit of Lorries Transport

| <i>Types</i> | <i>Market J</i> | <i>Market K</i> | <i>Market L</i> | <i>Market M</i> | <i>Market N</i> |
|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| <i>Ultrathin</i> | 60 | 91 | none | 55 | 64 |
| <i>ESE27</i> | 65 | none | 63 | none | 56 |
| <i>UFO Series</i> | 48 | 66 | none | 61 | 47 |

Draw the network model for this transportation problem.

(12 marks)

- b) Eco-Green Enterprise just introduced a new portable air conditioner. As part of its promotional campaign, the marketing department decided to send personalized invitations to test use the new portable air conditioner to two target groups:

- (1) The existing customers of Eco-Green Enterprise
- (2) The potential customers of Eco-Green Enterprise.

The cost of sending a personalized invitation to each customer is estimated to be \$1 per letter. Based on previous experience with this type of advertising, Eco-Green Enterprise estimates that 25% of the customers contacted from Group 1 and 10% of the customers contacted from Group 2 will test out the new portable air conditioner.

To be successful in this campaign, Eco-Green Enterprise had set the following goals:

Goal 1: Get at least 10,000 customers from Group 1 to test out the new portable air conditioner.

Goal 2: Get at least 5,000 customers from Group 2 to test out the new portable air conditioner.

Goal 3: Limit the expense of sending out invitations to \$70,000.

Assume that Goal 1 and 2 are P_1 priority level goals and that Goal 3 is a P_2 priority level goal. Suppose that Goal 1 and 2 are equally important; formulate a goal programming model of the Eco-Green Enterprise's problem.

(13 marks)

Continued...

QUESTION 2 (25 marks)

- a) A fabric firm has received an order for cloth specified to contain at least 45 pounds of cotton and 25 pounds of silk. The cloth can be woven out on any suitable mix of two yarns, *A* and *B*. Material *A* costs \$3 per pound, and *B* costs \$2 per pound. They contain the following proportions of cotton and silk (by weight):

| Yarn | Cotton (%) | Silk (%) |
|------|------------|----------|
| A | 30 | 50 |
| B | 60 | 10 |

- i) Develop the objective function to minimize total cost. (2 mark)
 ii) Develop the constraints for this problem. (4 marks)
 iii) Solve graphically. What quantities (pounds) of *A* and *B* yarns should be used to minimize the cost of this order? (8 marks)
 iv) How much is the minimum cost used by referring to the optimum solution in question (iii)? (1 mark)
- b) A tourist is considering travel to one of the following destinations for vacation. Eight criteria, criteria weights, and destination ratings are also shown. What is the recommended choice?

| Criteria | Weight | Ratings | | | |
|-------------------------------------|--------|-----------|-----------|-----------|-----------|
| | | Country A | Country B | Country C | Country D |
| Environmental quality | 3 | 8 | 6 | 7 | 5 |
| Safety and security | 4 | 3 | 5 | 8 | 7 |
| Hygiene and cleanliness | 5 | 4 | 5 | 8 | 7 |
| Travelling fee | 5 | 5 | 8 | 3 | 6 |
| Distance from home | 2 | 7 | 8 | 7 | 6 |
| Availability of shopping facilities | 4 | 9 | 5 | 4 | 6 |
| Basic facilities | 4 | 6 | 5 | 7 | 6 |
| Special events and attractions | 3 | 5 | 3 | 8 | 5 |

(10 marks)

Continued...

QUESTION 3 (25 marks)

- a) The following showed the output of linear programming problem for Pear Corporation in determining the amount of S1102 printer and D1102 printer to be stocked. The objective function measures profit; it is assumed that every piece stocked will be sold. Constraint (1) measures display space in units, constraint (2) measures time to set up the display in minutes. Constraints (3) and (4) are marketing restrictions.

LINEAR PROGRAMMING PROBLEM

MAX 10S+9D

S.T.

- (1) $0.7S+1D \leq 630$
- (2) $0.5S+0.83333D \leq 600$
- (3) $1S+0.66667D \leq 708$
- (4) $0.1S+0.25D \leq 135$

OPTIMAL SOLUTION

Objective Function Value = 7667.99417

| Variable | Value | Reduced Costs |
|----------|-----------|---------------|
| S | 539.99842 | 0.00000 |
| D | 252.00110 | 0.00000 |

| Constraint | Slack/Surplus | Dual Prices |
|------------|---------------|-------------|
| 1 | 0.00000 | 4.37496 |
| 2 | 120.00071 | 0.00000 |
| 3 | 0.00000 | 6.93753 |
| 4 | 17.99988 | 0.00000 |

OBJECTIVE COEFFICIENT RANGES

| Variable | Lower Limit | Current Value | Upper Limit |
|----------|-------------|---------------|-------------|
| S | 6.30000 | 10.00000 | 13.49993 |
| D | 6.66670 | 9.00000 | 14.28571 |

RIGHT HAND SIDE RANGES

| Constraint | Lower Limit | Current Value | Upper Limit |
|------------|-------------|---------------|----------------|
| 1 | 495.60000 | 630.00000 | 682.36316 |
| 2 | 479.99929 | 600.00000 | No Upper Limit |
| 3 | 580.00140 | 708.00000 | 900.00000 |
| 4 | 117.00012 | 135.00000 | No Upper Limit |

Continued...

Use the output to answer the questions.

- i) How many S1102 printers should be stocked? (1 mark)
 - ii) How many D1102 printers should be stocked? (1 mark)
 - iii) How much space will be left unused? (2 marks)
 - iv) How much time was used? (2 marks)
 - v) By how much will the first marketing restriction be exceeded? (2 marks)
 - vi) How much is the profit? (1 mark)
 - vii) By how much can the price of S1102 printer allowed to drop before the solution would change? (2 marks)
 - viii) By how much can the right-hand side of constraint (2) increase before the solution would change? (2 marks)
- b) MM Manufacturing produces two popular grades of Caucasian carpet. In the coming production period, MM needs to decide how many rolls of each grade should be produced in order to maximize profit. Each roll of Grade A carpet uses 50 units of synthetic fiber, requires 25 hours of production time, and needs 20 units of foam backing. Each roll of Grade B carpet uses 40 units of synthetic fiber, requires 28 hours of production time, and needs 15 units of foam backing.
- The profit per roll of Grade A carpet is \$200 and the profit per roll of Grade B carpet is \$160. In the coming production period, MM has 3000 units of synthetic fiber available for use. Workers have been scheduled to provide at least 1800 hours of production time (overtime is a possibility). The company has 1500 units of foam backing available for use. Develop and solve a linear programming model for this problem. (12 marks)

QUESTION 4 (25 marks)

- a) List and explain with example **FOUR (4)** types of Queuing System Models. (12 marks)
- b)
- $$\text{Max } 70X + 50Y$$
- s.t.
- $$\begin{aligned} 2X + 1Y &\leq 100 \\ 4X + 3Y &\leq 240 \\ X, Y &\geq 0 \end{aligned}$$
- i) Converting the constraints into equations with slack variables. (3 marks)
 - ii) Develop the initial simplex tableau. (3 marks)
 - iii) Identify the pivot column. (2 marks)
 - iv) Identify the pivot row and pivot number. (2 marks)
 - v) Develop the second simplex tableau. (3 marks)

End of Paper

